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Sustainable Diets, Food, and Nutrition

Proceedings of a Workshop—in Brief

On August 1 and 2, 2018, the Food Forum of the National Academies of Sciences, Engineering, and Medicine hosted a public workshop in Washington, DC, on sustainable diets, food, and nutrition. The workshop objectives were to review current and emerging knowledge on the concept of sustainable diets within the field of food and nutrition; explore sustainable diets and relevant impacts for cross-sector partnerships, policy, and research; and discuss how sustainable diets influence dietary patterns, the food system, and population and public health. The workshop was organized into four main sessions and a closing panel discussion of selected speakers. This Proceedings of a Workshop—in Brief summarizes the key points made by the workshop participants during the presentations and discussions and is not intended to provide a comprehensive summary of information shared during the workshop.¹ The views summarized here reflect the knowledge and opinions of individual workshop participants and should not be construed as consensus among workshop participants or the members of the Food Forum or the National Academies.

WHAT ARE SUSTAINABLE DIETS?

The workshop began with an exploration of the complexities and compromises required to move toward sustainable diets. The first speaker of session 1, which was moderated by Fergus Clydesdale, University of Massachusetts Amherst, was Adam Drewnowski, University of Washington. Citing the definition of sustainable diets articulated at a 2010 symposium hosted by the Food and Agriculture Organization (FAO) of the United Nations, Drewnowski emphasized that sustainable diets are those that are not only healthy for humans and good for the environment, but also affordable and acceptable to society:

Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources. (FAO, 2012)

Drewnowski discussed four important domains of sustainable diets, including (1) nutrition and health, (2) economics, (3) society and culture, and (4) environment. Sustainable diets encompass inherent tensions and contradictions because of these multiple domains. One basic contradiction is that some energy-dense foods are cheaper and have a lower impact on the environment, but they are not nutritious. An extreme case is sugar. “If you want a plant food with the lowest land cost, lowest water use, and lowest greenhouse gas (GHG) emissions,” Drewnowski said, “look no further than sugar.” He discussed how the trade-offs and compromises required of these tensions and contradictions demand a focus on food systems, not on individual foods, and how future impacts will require using integrated data from both private- and public-sector sources. Each of the four domains of sustainability relies on a different metric, or set of metrics, Drewnowski continued. When assessing nutrition, common measures include energy

¹ Presentations, videos, and other materials from the workshop can be found at nationalacademies.org/foodforum (accessed October 2, 2018).

density (calories per gram) and nutrient density (nutrients per calorie). A common environmental measure is carbon cost, which Drewnowski prefers to measure from the standpoint of calories, not grams, because it reveals a direct linear relationship between the nutrient density of foods and their carbon costs. He said, “this is where compromises need to be made. Nutrient-rich foods actually are more costly from the standpoint of energy than are candy and sugar.” Finally, with respect to the social dimension, Drewnowski called for measuring eating patterns rather than individual foods or nutrients when assessing the relationship between diet and health outcomes.

Jessica Fanzo, Johns Hopkins University, continued by stating that sustainability in the context of diet is not a new issue. She mentioned Joan Dye Gussow’s work in the 1970s and the many reports that have been published since then. The difference between past and current dialogue about sustainable diets is that, early on, most of the conversation centered on the environmental impacts of food systems. Reiterating one of Drewnowski’s key points, Fanzo emphasized that it is widely recognized today that there is more to sustainability. The challenge, she said, is how to turn FAO’s 2012 definition of sustainable diets described by Drewnowski into a feasible reality, particularly for those living in low- and middle-income contexts and in countries where massive inequalities force policy makers to make tough decisions about what to prioritize. As an example, she mentioned palm oil in Indonesia and Malaysia. While it is not great for the environment, nor is it great for human health, palm oil is great for economic growth, she said.

Fanzo was the first of many speakers to highlight the rapid economic, urban, and food system transitions that many low- and middle-income countries are undergoing, particularly the growing demand for meat. “I cannot emphasize that enough,” she said. In Myanmar, where she does a lot of work, Kentucky Fried Chicken has become what Fanzo described as “the hippest restaurant” because “it taps into the desire for meat.” It is not just that the demand for meat is increasing but the availability of animal feed to produce more meat is moving to more areas of the world. “This whole system needs to be rethought,” she urged. While Fanzo agreed with Drewnowski that new evidence is needed to understand what constitutes a sustainable diet for different populations and contexts, she urged greater consideration about what to do with the evidence. Recognizing that policy making is a messy, unpredictable, complex process, she called for greater engagement between scientists and policy makers in the process.

Parke Wilde, Tufts University, explained that another challenge created by the inherently multi-sectoral nature of sustainable diets is the communication of information among the different sectors, each with its own thoughts and goals, particularly given the contentious nature of sustainability. He pointed out that, in addition to documents, food labels, workshops such as this one, and other tools, food prices also contain significant information. He likened food prices to the aperture on a camera—it seems like a little hole, but in fact, a lot of information passes through it, including information about sustainability, such as how much healthy food will cost a consumer. Moreover, Wilde said, conversations about sustainable diets play out differently in low-priced versus high-priced environments. For example, decisions surrounding land conservation (e.g., whether to withhold land from agricultural production) are easier to determine in a low-priced environment, whereas decisions about incentives to reduce food waste are easier to conduct in a high-priced environment. Wilde explained that history has shown how food prices fluctuate over time. U.S. Department of Agriculture (USDA) projections for future food prices through 2027 show fewer fluctuations, but in Wilde’s opinion, those projections are based on some controversial assumptions. He cautioned that the goal should be to focus on pursuing a sustainable diet strategy that can accommodate both abundance (low prices) and scarcity (high prices). “We need to be braced for both,” he said.

MEASUREMENT AND ANALYSIS OF SUSTAINABLE DIETS FROM PRODUCTION TO CONSUMPTION

In session 2, moderated by Diego Rose, Tulane University, speakers examined the challenges and opportunities for measuring diet and modeling the human and environmental impacts of dietary and agricultural changes from production to consumption.

Ashkan Afshin, Institute for Health Metrics and Evaluation, University of Washington, opened the session by reiterating what Drewnowski stated about there being many different sources of sustainable diet data and emphasizing that no single source is perfect. For example, food availability data are usually good in terms of coverage, but they reveal nothing about actual consumption. Afshin described how, in his work with the Global Burden of Disease Study, data from multiple sources are being standardized and combined to estimate fruit, red meat, and other dietary intakes at the population level in different regions across the world. The process is updated annually, he noted. In addition to comparing country intakes to recommended levels, the results are also being used to answer other questions, such as how people replace a food item when it is recommended that they reduce their consumption of that item.

Standardizing data from different sources so that they are comparable is only one of several challenges to measuring diet, Afshin continued. Scientists also contend with differences in how diet is characterized (e.g., in terms of food, nutrients, or dietary patterns), inconsistency across studies in how dietary factors are defined (e.g., “whole grain” is among the most challenging), and uncertainty around how to quantify serving size. Afshin concluded by emphasizing that, despite these many challenges, multiple lines of evidence indicate that diet is an important risk factor for the health of both people and the planet.

Echoing Fanzo's call for more engagement with the policy making process, he urged, "we cannot wait for perfect data in order to make decisions."

Delving more deeply into the inter-relationships between diet and the health of both people and the planet, David Tilman, University of Minnesota, emphasized that while much of today's dialogue on the environmental impacts of food revolves around GHG emissions, there are other significant environmental impacts of food. In particular, eutrophication (i.e., excessive nutrient runoff into bodies of water) is a major cause of water pollution and subsequently contributes to species extinction as a result of land clearing. In fact, according to Tilman, many ecologists assert that eutrophication and extinction are as problematic as climate change with respect to the long-term sustainability of the support systems on which humanity depends.

Tilman shared results from several studies showing, on average, large environmental benefits associated with healthier foods. Building on Fanzo's remarks about how the world is currently experiencing a rapid nutrition transition, including a growing demand for meat, he shared predictions showing that if the current global dietary transition continues, by 2050 GHG emissions from global agriculture will have increased by more than what the entire global transportation sector emits today. However, if people were to adopt more plant-based diets, the increase in GHG emissions from global agriculture would potentially be even lower than it is now. The predictions for eutrophication parallel those for GHG emissions, with animal-based foods causing more eutrophication than plant-based foods. Tilman remarked that, while maize is considered a crop with a high eutrophication effect, in fact, the dead zone (hypoxic areas in the world's oceans and large lakes) caused by all of its leftover nutrients draining down the Mississippi River is "nothing compared to beef." This is because it takes about 15 kilograms of protein coming from maize to make one kilometer of edible beef protein, he explained. With respect to extinctions, assuming an 80 to 100 percent increase in agricultural crop demand over the next 50 years, models predict a marked increase in extinction risk due to land being cleared to accommodate this increased production. Most of the Earth's large mammals would be on the brink of extinction. The good news, Tilman said, is that, as with GHG emissions and eutrophication, diet can help to prevent some of this damage.

However, as much as he emphasized diet being a "big lever" for reducing the environmental impact of the food system, Tilman also underscored the importance of, as he put it, "do[ing] agriculture in a more precise way."

Like Tilman, Mark Rosegrant, International Food Policy Research Institute (IFPRI), called attention to the intense pressure that global population growth and changing food demands will continue to place not just on the climate, but also on land and water. He described what IFPRI's IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade) modeling system has revealed about future GHG, land, and water impacts under a range of different agricultural investment and reduced meat demand scenarios, such as what to expect if a comprehensive agriculture portfolio investment totaling \$25.5 billion per year above baseline were to be implemented over a 35-year period from 2015 to 2050. The investments would cover agricultural research and development, the expansion of irrigation systems, and the enhancement of water use efficiency, soil management, and rural infrastructure. The model predicted substantial increases in per capita income and agricultural supply, as well as reductions in hunger and stunting, GHG emissions, and water and land use.

One of the reduced meat demand scenarios involved a forced 50 percent reduction in per capita meat demand in all high-income countries plus Brazil and China. One of the most important findings in this scenario, Rosegrant pointed out, was the significant increase in meat consumption in sub-Saharan Africa—more than 30 percent from its current low level. Meat consumption would also increase significantly in other developing countries. Rosegrant explained that reduced meat consumption in currently high meat consumption countries would drive down prices, making meat more affordable elsewhere. Other predicted impacts of reduced meat consumption included reduced feed grain demand, lower grain prices, and a modest reduction in hunger; large reductions in GHG emissions; and substantial reductions in land loss.

Based on the results of these two sets of modeling scenarios, Rosegrant called for a balanced approach to achieving sustainable and resilient food systems—one that recognizes the need for both increased agricultural investment and significant dietary changes.

SUSTAINABILITY AND HEALTHY DIETARY CHANGES THROUGH POLICY AND PROGRAM ACTION

In session 3, moderated by David Klurfeld, USDA, speakers explored what modeling and other studies suggest about program and policy actions that can support sustainable diets.

The session began with Marco Springmann, Oxford University, United Kingdom, commenting that although sustainable diet research is yielding an increasing number of systematic reviews, most of these reviews are still focused on national case studies that rely on different approaches. "It is hard to make sense of the totality of the literature," he said. In addition, the predominant environmental focus is still on GHG emissions, with few studies examining land and water use. Moreover, health impacts are often not analyzed beyond simple adherence to dietary guidelines or directional changes in nutrient levels. To help get a better sense of the totality of the data, Springmann and his colleagues conducted a large modeling analysis of the health and environmental impacts of three different dietary change strategies among 158 countries (Springmann et al., 2018). The first strategy focused on dietary patterns by substituting animal-based products in diets with plant-based products; the second

focused on balanced, or normalized, energy intake (i.e., reduced underweight, overweight, and obesity); and the third, the “public health strategy,” balanced both the energy intake and the dietary patterns. The model predicted that by 2030, while all three strategies lead to a reduction in premature mortality, the greatest reduction would come from the public health strategy (i.e., about double that of either other scenario). Based on these results, Springmann opined that pushing for both balanced energy intake and balanced dietary patterns could “deliver quite a bit” toward achieving sustainable diets.

Springmann and his colleagues also examined regional differences by grouping countries by income. There, they saw more trade-offs among the three strategies, particularly among low-income countries. For example, when animal source products were substituted with plant source products, although all regions still experienced reductions in premature mortality and large reductions in GHG emissions, low-income countries also experienced a high increase in cropland use and also increases in nitrogen and phosphorous application. Springmann interpreted these results to mean that while it would be possible in many high- and middle-income countries to align health and environmental concerns by 2030, even with advances in technology, it would be practically impossible in much of the rest of the world to reduce diet-related premature mortality while also reducing environmental impacts.

Touching on Drewnowski’s early emphasis on the multiple domains of sustainable diets, Jennie Macdiarmid, University of Aberdeen, Scotland, elaborated on the importance of modeling not just the human and environmental health impacts of various policy or programmatic changes, but also what she called the “human element.” She described modeling results demonstrating that, while it may be possible to have an affordable diet that meets all nutrient requirements and also leaves a maximally reduced carbon footprint (90 percent reduction in GHG emissions), doing so means eating nothing but bran flakes, pasta, peas, a few onions, and a bit of chocolate. But people do not eat just for health reasons or because they want to protect the environment. When thinking about how to get people to actually change what they are eating, taking into account choice and cultural and social acceptability is “absolutely key,” Macdiarmid stressed.

Macdiarmid called for a greater understanding of what is actually driving the choices people make and expressed worry that, without this understanding, a push for sustainable diets will be stalled at the guideline stage. With respect to reducing animal or meat consumption, one of the challenges that will need to be addressed is what Macdiarmid described as a “panic” that eating less meat will lead to protein deficiency. A recent study she mentioned signaled that even if all meat was removed from the UK nutrient supply chain, the UK population would still have about 125 percent of its protein supply. Focusing on protein replacement is a distraction, in her opinion. Another challenge to reducing meat consumption is how to frame it, as “eat less meat” is not currently an acceptable message. Yet, another challenge is the problems with many of the meat alternatives being promoted, like insects. Insects are bio-accumulators of heavy metals, she noted, and thus raise serious food safety issues. Another key point for Macdiarmid was that there is no single or average plant-based diet, but rather a range of plant-based diets that can have implications for environmental impact.

A recurring theme, one that Janet Ranganathan, World Resources Institute (WRI), highlighted, was that there is no easy fix, rather a menu of solutions for achieving sustainable diets. Although WRI recognizes that shifting diets may be a “shinier silver bullet” than other strategies, she warned, “we need all the solutions on the table.” Revisiting strategies already discussed by previous speakers, but also adding new ones, she listed a range of production strategies: boosting yields through crop breeding, improving soil and water management, expanding onto degraded lands, and increasing livestock and pasture productivity. In her opinion, given that land developed for livestock production is about twice the land used for crops, there is a lot of what she called “low-hanging fruit,” particularly in countries outside of the United States, with respect to opportunities for increasing the productivity and sustainability of livestock production. Similarly, revisiting strategies already discussed by previous speakers, but also adding new ones, she listed several consumption strategies: reducing food loss and waste, achieving replacement level fertility, reducing biofuel demand for food crops, and shifting diet. Building on Macdiarmid’s discussion of the challenges to shifting individuals’ dietary choices around meat consumption, Ranganathan suggested that lessons learned from private-sector marketing may help. The private sector, she said, “is fabulously good at shifting people toward behavioral changes.” Based on a WRI review of 20 successful consumption shifts, Ranganathan described several common strategies. One is to minimize disruption, for example, by marketing soy milk in the refrigerated section because that is where people habitually go to get their milk, even though soy milk does not require refrigeration. Another is to maximize awareness, for example, by placing items at the end of an aisle. In addition, Ranganathan described how WRI has also been experimenting with strategies to use in the food services sector, ranging from changing menu language, for example, by describing an entrée as “roasted butternut squash with sweet and spicy coconut sauce and fresh Thai basil” instead of “baked squash with rice and grits,” to popularizing dishes rich in plants. As an example of the latter, in addition to the popular “veggie sandwich wrap,” WRI is working with companies to include menu items such as blended mushroom-beef burgers. In the United States, given that about 1 billion beef burgers are sold annually, removing just 30 percent of beef from a burger and replacing it with mushroom would be the equivalent of removing 2.3 million cars off of U.S. roads.

While most of the workshop discussion on policy and program actions that can support sustainable diets revolved around production versus consumption strategies, Maha Tahiri, former food industry executive, viewed the challenges and opportunities at hand through a different lens: nutrition sensitive value chain (NSVC) interventions. Historically, she explained, the focus of most food chain interventions was on yield or farmer well-being. The concept of an NSVC, with its focus on nutritional value, not just economic value, emerged about 10 years ago in response to studies showing that traditional interventions (e.g., food fortification) are not enough to achieve global nutrition targets. In Tahiri's opinion, the NSVC concept is a nice way to unpack the complexity of the food system and think about interventions in a more expansive way. She pointed out that, in addition to focusing on nutritional value at each step of the food chain, the FAO-based Global Forum on Food Security and Nutrition's definition of NSVC also places a focus on sustainability.

The last speaker of the day was Barbara Schneeman, University of California, Davis, who had recently served on a National Academies committee to examine the process for establishing the *Dietary Guidelines for Americans* (DGA) (NASEM, 2017). In the resulting report, the committee identified three essential functions conducted by the DGA Advisory Committee: (1) strategic planning, (2) analysis, and (3) synthesis and interpretation. Each function would be handled by separate committees over a 5-year cycle. Schneeman considered the opportunities and ways that sustainability could be integrated into each of these functions. She suggested that, during strategic planning phase, sustainability could be addressed, first, by prioritizing new topics to examine them in subsequent DGA cycles and, second, by considering how the purpose statement of the DGA should address sustainability. Currently, explicit mention of sustainability is neither on the list of topics slated for future consideration nor in the purpose statement. During the analysis phase, the National Academies committee proposed the use of technical expert panels (TEPs) to provide independent consultation (NASEM, 2017). As a way to address sustainability, Schneeman suggested that these TEPs could include experts who are able to identify descriptive data analyses and food pattern models that are relevant to sustainability or to define sustainability-related research questions that can be addressed through systematic review. Finally, during the synthesis and interpretation phase, the DGA Advisory Committee synthesizes, interprets, and integrates the data, evidence, and studies identified during the analysis phase and then develops recommendations. Schneeman suggested that this third phase committee could include experts who have the appropriate knowledge to review the sustainability-related evidence identified earlier during the process.

INNOVATIONS IN FOOD PRODUCTION AND DISTRIBUTION TO REDUCE ENVIRONMENTAL FOOTPRINT

Building on the foundation developed on the first day of the workshop, in session 4, moderated by Kate Houston, Cargill, Inc., speakers continued to explore food system innovations to address sustainability. Some of these innovations have already been implemented, Houston remarked, while others are on the horizon.

Opening the session with a focus on innovations in food production, in particular livestock production, Frank Mitloehner, University of California, Davis, addressed throughout his talk what he described as “seemingly conflicting” statements about livestock and climate change. The first of these were claims that livestock is the predominant contributor of GHG emissions globally, producing 18 percent of all GHG emissions, and that livestock emits more GHGs than transportation does. Mitloehner clarified that the 18 percent figure, first reported in *Livestock's Long Shadow* (FAO, 2006), was later revised to 14.5 percent and that the majority of that percentage is related to deforestation in developing and emerging countries. Mitloehner asserted that, arguably, the greatest contributor of the food supply to GHG emissions is not livestock, but food waste. According to Mitloehner, in the United States, 40 percent of all food produced goes to waste. Globally, that figure is closer to 30 percent.

The claim that livestock emits more GHGs than transportation derives from the same 2006 FAO report, a finding that Mitloehner has been critiquing since that report was published because different methods were used to estimate the sectors' emissions. Specifically, a life-cycle assessment was used to estimate the livestock sector emissions, taking into account all aspects of livestock production, whereas only direct emissions (i.e., tailpipe emissions) were used to estimate emissions from the transportation sector. According to Mitloehner, for example, direct emissions data from the U.S. Environmental Protection Agency show that in California, the livestock sector contributes 5.4 percent of total GHG emissions in the state and the transportation sector contributes 36.9 percent.

Two additional “fact or fiction” statements Mitloehner addressed were, first, that livestock occupies 70 percent of all agricultural land globally and, second, that grazing systems produce less GHG than conventional animal production in confinement systems. Regarding the first statement, Mitloehner explained that the majority (two-thirds) of all agricultural land worldwide is considered marginal, which means that it cannot be used as cropland either because the soil is infertile or there is not enough moisture; therefore, its only agricultural use is for livestock, in particular ruminant livestock (e.g., beef, dairy, goats, sheep). Mitloehner addressed the second statement by explaining that, in fact, the relationship between production intensity and emission intensity is an inverse one. In the United States, about 25,000 pounds of milk are produced per cow per year. In contrast, in India, a dairy cow produces up to 20 times less milk per year. The cumulative environmental impacts of 1 versus 20

cows are vastly different, he asserted. “The more efficient you are in agricultural production,” Mitloehner said, “the relatively smaller your environmental footprint.”

Martin Heller, University of Michigan, moved the conversation from production to demand-side innovation, specifically dietary choice, and thus revisited some of what was discussed on the first day of the workshop but with a focus on the United States rather than global trends. He described several approaches used to predict how potential shifts in the U.S. diet might reduce the environmental impact of the food system. He acknowledged that production-side improvements, such as what Mitloehner discussed, help to reduce GHG emissions, but, in Heller’s opinion, they will not be sufficient to meet the 2015 Paris Agreement’s 2°C climate change target. Meeting that target requires demand-side reductions, including reduced animal-based food consumption.

First, Heller described results from his own work predicting what would happen if the average U.S. diet shifted to one of the DGA recommended eating patterns (omnivorous, vegetarian, or vegan). Heller and his colleagues found that, for an omnivorous diet, if caloric intake remained the same, there would be a 12 percent increase in GHG emissions; if caloric intake were reduced to levels closer to government recommendations, GHG emissions would be about the same as they are now (Heller and Keoleian, 2015). In contrast, for a lacto-ovo vegetarian diet, total GHG emissions would decrease by 33 percent, and for a vegan diet, they would decrease by 53 percent. Heller and Keoleian (2014) showed that if the average U.S. diet shifted to Harvard’s Healthy Eating Plate, which approximates the omnivorous DGA pattern but with less meat and dairy, GHG emissions would decrease by the same amount as the lacto-ovo DGA diet (33 percent). This latter finding led Heller to reiterate what Macdiarmid said about there being a range of diets that can reduce the environmental impact of food.

Another approach that has been used to predict how dietary shifts among Americans would change the environmental impact of the U.S. food system is to estimate how the carrying capacity of U.S. agricultural land (i.e., the number of persons that can be fed from that land) changes under varying diet scenarios. Heller explained that the current carrying capacity of U.S. agricultural land is about 130 percent of the 2010 population, with the excess being exported. If the average U.S. diet were to shift to one of the DGA eating patterns, the carrying capacity would increase to between 136 percent (100 percent omnivorous) and 261 percent (100 percent lacto-vegetarian).

But all of these predictions are for the “average” U.S. diet, Heller cautioned. Agreeing again with Macdiarmid, he said, “there is no such thing as an average diet.” Thus, Heller and his colleagues conducted a study linking GHG emissions to individual diets using National Health and Nutrition Examination Survey (NHANES) data for 16,800 individuals and more than 7,000 food items. For Heller, the most interesting finding from this work was the ability to look at emissions as a distribution. He and his colleagues were struck by the extent of the variation. “We knew there was going to be variance,” he said, “but it is much greater than we were anticipating.” When they ranked individual diets by GHG emissions and then divided the data into quintiles, with top emitters in the fifth quintile and bottom emitters in the first quintile, they observed an eight-fold difference in cumulative emission intensity between the fifth and first quintiles. They attributed the differences in emission among the quintiles partly to calories, with top emitters eating more calories, but there were also significant differences in diet composition: top emitters eat a lot more beef than bottom emitters (see Figure 1-1). Heller explained how, if top emitters were to shift to an average emission diet (i.e., eat the equivalent of one-quarter of a pound of beef every other day instead of one-third of a pound daily), after 1 year the reduction in GHG emissions would bring the United States 10 percent closer to achieving the 2°C climate target.

Moving the discussion away from production versus demand side innovation, Nicole Tichenor Blackstone, Tufts University, considered how local and regional food systems can help to achieve sustainable diets. The central argument of this “food systems transformation” perspective, she explained, is that the sustainability problems of the type being addressed at this workshop are a result of the social and economic organization of food systems and that there may be alternative ways of organizing farms and supply chains.

Tichenor Blackstone described three ways that local and regional food systems can contribute to sustainable diets. First, they can strengthen economic viability. Studies have shown, for example, that farms working in local supply chains, as opposed to mainstream chains, have higher net revenues, and that farms that use direct marketing channels (e.g., farmers’ markets) have higher survival rates. Second, local and regional farms can improve access and health. There is evidence to suggest, for example, that prices for vegetables may be lower at farmers’ markets compared to retail outlets. Third, they can reduce environmental impact. Tichenor Blackstone asserted that although the transportation footprint increases with local supply chains in some cases, in fact, transportation is a small part of the overall environmental footprint of foods. She encouraged workshop participants to focus on other components of foods’ environmental footprint.

To illustrate how local and regional farms can reduce environmental impact, she described some of her work on alternative beef production systems in the northeastern United States, where regional dairy systems are producing both milk and beef and leaving a smaller environmental footprint than other nearby beef production systems in terms of both methane emissions and land use. These systems tend to rely heavily on corn-based feeds. Tichenor Blackstone and colleagues were curious

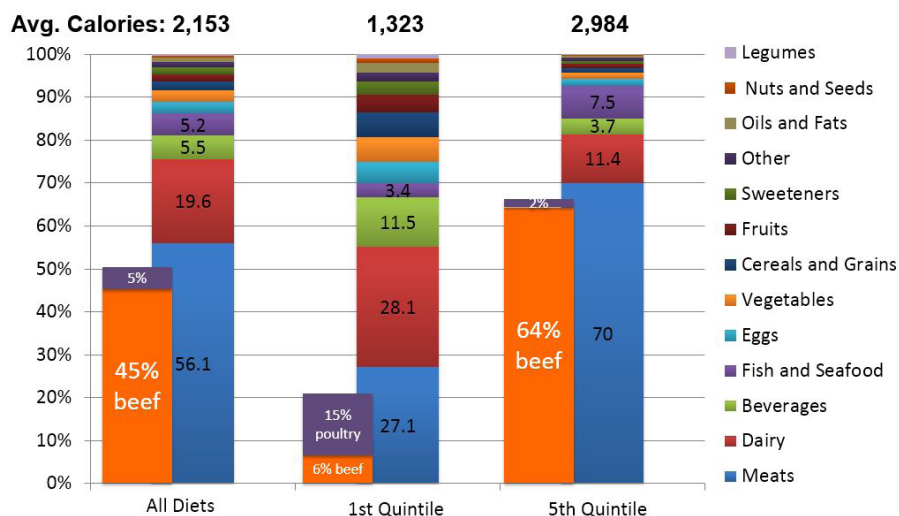


FIGURE 1 Percent contributions from food groups to total GHGE for all diets, 1st quintile diets (bottom emitters), and 5th quintile diets (top emitters).

SOURCE: Presented by Martin Heller on August 2, 2018, modified from Heller et al., 2018.

about whether using food waste as feed, something that resembles corn, might improve the sustainability of these regional dairy systems even further. She explained that, currently, many states are pushing policies to encourage the conversion of food waste to biofuel via anaerobic digesters. The results of Blackstone and colleagues' work indicated net benefits from using that food waste as animal feed instead. Tichenor Blackstone called for further assessment of this "leftovers approach."

In the final presentation of this session, Karrie Denniston, Walmart, emphasized that retailers like Walmart can play a uniquely important role in achieving sustainable diets because of where they sit at the interface between supply chains and consumer demand. Given its size and scope, with about 11,000 stores around the world and sourcing from about 100 different countries, Walmart has learned many lessons about the ways to support a more sustainable food system. She went on to describe several of these lessons, but first reiterated one of Drewnowski's early messages of the workshop regarding the complexity of supply chains and the reality that, as Denniston put it, "when we maximize for one thing, we create issues somewhere else." As an example, she pointed to the plastic waste created when food is packaged differently to extend shelf life and reduce food waste.

One of the lessons learned by Walmart, she noted, is that defining what good looks like is a powerful tool, as it points people toward what they should be doing. Dietary guidelines are a good example of that, Denniston said, as is the Paris Agreement's 2°C goal. As an example of Walmart's work in this area, the retailer has been investing in small and medium enterprises in China and helping them to understand how to mitigate food safety risks, with the first step being to agree on a shared understanding of what it means to have food safety practices. Another lesson learned is the importance of transparency. The greater the visibility into a supply chain, the greater the opportunity to respond, Denniston said. Yet, another lesson learned is that consumer engagement helps drive demand. For example, Walmart now uses a "best if used by" label on 92 percent of the retailer's private label brands in the United States. The label helps consumers navigate confusion around expiration dates. According to Denniston, this one small change has eliminated an estimated 660 million pounds of food waste and illustrates the role that retailers can play in providing consumers with sustainability guidance and tools in a more tailored, systematic way.

In the question and answer period at the end of this session, much of the discussion revolved around the relative importance of improving the efficiency of livestock production versus shifting the human diet toward more plant-based eating. Mitloehner clarified that he agreed that beef is an important driver of GHGs and that the increasing global demand for beef will have a significant impact. However, in his opinion, addressing the inefficiencies in livestock production, particularly in the developing world, is a key tool for reducing the global carbon footprint of the human diet.

CLOSING DISCUSSION

In the concluding session of the workshop, moderator Eric Olson, Natural Resources Defense Council, asked each of the five panelists to reflect on the workshop and share their takeaways.

Fanzo described how someone without expertise in a particular area can "go down a rabbit hole" and believe that whatever data or report that they come across is robust. Given the difficulty that even she has interpreting climate data, she remarked that it must be incredibly hard for consumers, producers, and policy makers to "weed through" and make sense of

much of the science. Reflecting on the controversy surrounding *Livestock's Long Shadow* (FAO, 2006), with some people believing what is in the report and others being very critical, she said, “you can unpack that across every report.” Nonetheless, Fanzo expressed hope. Having conversations such as the one occurring at this workshop was, for her, “a promising step compared to where we were 5, 10 years ago.”

For Tilman, the issue of equity was a recurring theme over the course of the workshop. He opined that the world will be stable in the long term only if equity exists both within and across societies. With that in mind, he asked, “What do we on average, as a citizen of Earth, have the right to do if we are going to have a world that is really equitable and sustainable in the long term?” While he acknowledged not having an answer, in his opinion, much of the change needed is behavioral, with the hardest question being how to agree as individuals, as nations, and as a global community on the choices that will need to be made regarding food, energy, land, water quality, and other sustainable diet issues.

In Springmann’s opinion, all of the data thus far suggest that a sustainable diet will probably require a shift toward a more plant-based diet. He clarified, however, that this does not mean that everyone needs to become vegan, rather it simply means a shift toward more plant-based eating. The challenge is, how? He referred to Ranganathan’s presentation on lessons learned from private-sector marketing on how to shift behavior and speculated that, while it is probably unrealistic to expect people to remove meat from their diets entirely, it is likely that some people might eliminate animal-based foods for a certain amount of time each week. He encouraged the retail sector to provide plant-based products so that people have that choice.

The main takeaway for Drewnowski was that achieving sustainability will require the involvement of multiple sectors and disciplines—from social scientists to epidemiologists to the food industry. He reminded the workshop that the environment is only one of four domains of a sustainable diet and that narrowly focusing on it can be misleading, especially because the environmental context of the food system is different from one country or geography to another. Even within the United States, there are geographic differences. In addition, as for Tilman, the issue of equity was a prominent one for Drewnowski. He mentioned a 600 percent difference in obesity rates across Seattle based simply on where people live, reflecting a socioeconomic difference that “swamps” any kind of difference by race, ethnicity, age, or sex.

Finally, Rose drew a parallel between today’s discussion on sustainable diets and the dietary guidance process in the United States. The first DGA was issued in the late 1970s because it was decided, at that time, there was enough knowledge in the nutrition community to issue the guidelines. But there was also a desire to revisit the guidelines in 5 years to see if there should be any changes in the advice offered. “I think we are sort of at that point here with sustainable diets,” Rose said. Much is known and can be communicated to the public and policy makers about sustainable diets, but perhaps that information should be revisited in 4 or 5 years. Another takeaway for Rose was the importance of modeling at the individual level, such as what Heller had discussed, given that it is individuals who make decisions about what to eat. “That is where the change happens,” Rose said.♦♦♦

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For additional information regarding the workshop, visit nationalacademies.org/foodforum.

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